Certification Examinations
for Oklahoma Educators™

Oklahoma Subject Area Tests™

STUDY GUIDE

008 Earth Science

Oklahoma Commission
for Teacher Preparation

OK-SG-FLD008-03

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The first two sections of the study guide are available in a separate PDF file. Click the link below to view or print these sections.

Study Guide Introduction and General Information About the Certification Examinations for Oklahoma Educators

FIELD-SPECIFIC INFORMATION

- Test Competencies
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INTRODUCTION

This section includes a list of the test competencies, as well as a set of practice selected-response (multiple-choice) questions and one or more practice constructed-response assignments (if applicable), for the test field included in this study guide.

Test Competencies

The test competencies are broad, conceptual statements that reflect the subject-matter skills, knowledge, and understanding an entry-level educator needs to teach effectively in Oklahoma public schools. The list of test competencies for each test field represents the **only** source of information about what a specific test will cover and therefore should be reviewed carefully.

The descriptive statements that follow the competencies are included to provide examples of possible content covered by each competency. These descriptive statements are neither exhaustive nor exclusionary.

Practice Test Questions

The practice selected-response questions and any practice constructed-response assignments included in this section are designed to give you an introduction to the nature of the questions included in this OSAT test field. The practice test questions represent the various types of questions you may expect to see on an actual test; however, they are **not** designed to provide diagnostic information to help you identify specific areas of individual strengths and weaknesses or to predict your performance on the test as a whole.

To help you prepare for your OSAT, each practice selected-response question in this section is preceded by the competency it measures and followed by a brief explanation of the correct response. On the actual test, the competencies, correct responses, and explanations will **not** be given.

If the test field included in this guide has a constructed-response assignment, a sample response is provided immediately following the practice constructed-response assignment. The sample response in this guide is for illustrative purposes only. Your written response should be your original work, written in your own words, and not copied or paraphrased from some other work.

A description of the process that is used for scoring the constructed-response assignment is provided in addition to the OSAT performance characteristics and score scale.

When you are finished with the practice test questions, you may wish to go back and review the entire list of test competencies and descriptive statements for your test field.

SUBAREAS:

I. Foundations of Scientific Inquiry
II. Space Systems
III. Atmospheric Systems
IV. Geological Systems
V. Water Systems

SUBAREA I—FOUNDATIONS OF SCIENTIFIC INQUIRY

Competency 0001

Understand the relationships and common themes that connect mathematics, science, and technology.

The following topics are examples of content that may be covered under this competency.

Analyze similarities between systems in mathematics, science, and technology (e.g., magnitude and scale, equilibrium and stability, optimization).

Apply concepts and theories from mathematics, biology, chemistry, and physics to an earth science system.

Analyze the use of mathematics (including statistics) and other sciences in the design of a technological solution to a given problem.

Use a variety of software (e.g., spreadsheets, graphing utilities, statistical packages, simulations) and information technologies to model and solve problems in mathematics, science, and technology.

Competency 0002

Understand the historical and contemporary contexts of the earth/space sciences and their application to everyday life.

The following topics are examples of content that may be covered under this competency.

Analyze the significance of key events in the history of the earth/space sciences (e.g., the discovery of a galactic universe, the development of the plate tectonics model).

Assess the societal implications of earth/space science phenomena (e.g., earthquakes, erosion, rising sea levels).

Competency 0003

Understand the process of scientific inquiry and the role of observation and experimentation in explaining natural phenomena.

The following topics are examples of content that may be covered under this competency.

Analyze processes by which new scientific knowledge and hypotheses are generated.

Analyze ethical issues related to the process of scientific research (e.g., accurately reporting experimental results).

Assess the appropriateness of a specified experimental design to test a given hypothesis.

Assess the role of communication among scientists in promoting scientific progress.

Competency 0004

Understand the processes of gathering, organizing, reporting, and interpreting scientific data; and apply this understanding in the context of earth/space science investigations.

The following topics are examples of content that may be covered under this competency.

Evaluate the appropriateness of a given method or procedure for collecting data for a specified purpose.

Select an appropriate and effective graphic representation (e.g., graph, table, diagram) for organizing, analyzing, and reporting given experimental data.

Apply procedures and criteria for formally reporting experimental procedures and data to the scientific community.

Analyze relationships between factors (e.g., inverse, direct, linear) as indicated by experimental data.

Competency 0005

Understand types and uses of natural resources, the effects of human activities on the environment, and the need for stewardship to preserve the environmental integrity of the earth's ecosystems.

The following topics are examples of content that may be covered under this competency.

Demonstrate an understanding of the classification, uses, and importance of natural resources and methods of locating and obtaining natural resources.

Assess the positive and negative effects of human activities on the earth's environment (e.g., reclamation of strip mines, ocean dumping).

Evaluate strategies for dealing with environmental problems.

Competency 0006

Understand how to create, use, and interpret physical and mathematical models (e.g., maps, charts, graphs, diagrams) commonly used in earth/space science.

The following topics are examples of content that may be covered under this competency.

Evaluate the appropriateness of alternative models for conveying given information from earth/space science.

Demonstrate an understanding of the methods by which given physical and graphic models are created.

Classify different types of maps (e.g., topographic, geologic) used in earth/space science and analyze the information conveyed by each type of map.

Interpret diagrams relating to earth/space science.

Competency 0007

Understand equipment and materials used in earth/space science investigations, and apply procedures for their proper and safe use.

The following topics are examples of content that may be covered under this competency.

Analyze the principles upon which given instruments are based (e.g., microscope, telescope).

Demonstrate knowledge and applications of basic safety procedures in a laboratory situation.

Apply proper procedures for dealing with given accidents and injuries in the laboratory or in the field.

SUBAREA II—SPACE SYSTEMS

Competency 0008

Understand the structure, composition, and features of the earth, moon, and sun and the role of technology and exploration in obtaining knowledge about the earth, moon, and sun system.

The following topics are examples of content that may be covered under this competency.

Demonstrate an understanding of the physical characteristics of the earth (e.g., diameter, tilt of axis, distance from the sun) and how they can be determined.

Analyze methods by which the sun's diameter, surface temperature, chemical composition, and energy source are determined.

Relate surface features (e.g., maria, craters, mountains) of the earth's moon to events in the history of the moon.

Demonstrate an understanding of how space exploration has contributed to our knowledge of the earth, moon, and sun system.

Competency 0009

Understand the interactions among the components of the earth, moon, and sun system (including energy transmission and absorption).

The following topics are examples of content that may be covered under this competency.

Demonstrate an understanding of the consequences of the earth's relative position and motion with respect to the sun (e.g., length of day, change of seasons, length of year).

Analyze the consequences of the relative positions and motions of the earth, moon, and sun (e.g., phases of the moon, tides, eclipses).

Demonstrate an understanding of the solar surface as the immediate source of energy for the earth's surface.

Analyze the sunspot cycle and its possible effects on the earth's climate.

Competency 0010

Understand the scale and organization of the solar system, the role of gravity in the solar system, characteristics of the bodies within the solar system, and physical and mathematical models that describe these objects and their real and apparent motions.

The following topics are examples of content that may be covered under this competency.

Analyze characteristics (e.g., size, density, surface temperature) of the planets.

Analyze the apparent motion of celestial objects to infer solar system models (i.e., geocentric and heliocentric).

Apply Newton's and Kepler's laws to describe and predict the motions of the planets.

Competency 0011

Understand stars, their motions and life cycles, and the methods and technology used to study them.

The following topics are examples of content that may be covered under this competency.

Compare types of telescopes (e.g., optical, radio, infrared, ultraviolet) and the ways in which they are used to acquire information on star characteristics.

Compare types of stars (e.g., pulsars, Cepheid variables) and their characteristics.

Use the H-R diagram to analyze the life cycle of stars.

Analyze stellar life cycles to understand the formation and initial development of the solar system.

Competency 0012

Understand evidence regarding the size, structure, scale, and motions of the universe, the Milky Way galaxy, and the solar system.

The following topics are examples of content that may be covered under this competency.

Analyze evidence regarding the location of the solar system within the Milky Way galaxy.

Analyze historical methods of inferring the size, structure, and motions of the galaxy and the solar system (e.g., star observations and counts).

Analyze the evidence for current theories of the origin of the earth, the solar system, and the universe.

Analyze types of evidence used to infer scales of the solar system, the Milky Way galaxy, and the universe (e.g., in relation to relative size and distance).

SUBAREA III—ATMOSPHERIC SYSTEMS

Competency 0013

Understand the composition, structure, and properties of the earth's atmosphere and the mechanisms and effects of energy transfer involving the earth-atmosphere system.

The following topics are examples of content that may be covered under this competency.

Compare and contrast properties (e.g., density, composition, temperature) of the atmosphere from the earth's surface through the thermosphere, and understand the significance of changes in these properties.

Analyze how various wavelengths of solar radiation (e.g., ultraviolet, visible light, infrared) are affected as the radiation enters and passes through the atmosphere and is absorbed and radiated from the earth's surface.

Analyze the processes by which energy is transferred to and within the atmosphere (e.g., radiation, convection, conduction).

Analyze global wind patterns in terms of latitudinal variations in insolation and the Coriolis effect.

Competency 0014

Understand the properties of water, conditions in the atmosphere that favor phase changes, and the energy relationships among phase changes, cloud formation, and precipitation.

The following topics are examples of content that may be covered under this competency.

Relate the physical properties of water (e.g., high specific heat, surface tension) to the chemical structure and properties of water molecules.

Analyze energy changes involved in the transition between phases of water (e.g., latent heat).

Analyze atmospheric conditions under which fog and clouds with various characteristics form (e.g., adiabatic temperature changes, dew point, atmospheric stability).

Understand conditions under which precipitation forms, and predict the type of precipitation that will fall to the earth's surface under given conditions.

Competency 0015

Understand characteristics of broad-scale weather systems and local weather, the relationship between them, and the methods and instruments used to collect and display weather data.

The following topics are examples of content that may be covered under this competency.

Interpret symbols used on weather maps, and analyze the methods used to generate weather maps (e.g., computer models).

Analyze types and characteristics of air masses, their movements, and the kinds of fronts that form between air masses.

Analyze the horizontal and vertical movements of air in high- and low-pressure areas.

Demonstrate an understanding of the use of weather instruments (e.g., thermometer, psychrometer) for collecting given types of weather data.

Competency 0016

Understand the principles and technology of weather forecasting and the impact of weather on humans.

The following topics are examples of content that may be covered under this competency.

Analyze the use of weather models in forecasting.

Predict weather in a given location based on one or more weather maps.

Evaluate the role of computers and satellite photographs in generating weather forecasts.

Analyze types of hazardous weather to determine appropriate precautions, and demonstrate an understanding of the role of the National Weather Service in issuing weather alerts.

Competency 0017

Understand the locations and characteristics of the earth's major climatic regions, and analyze factors that affect local climate and the relationship between weather and climate.

The following topics are examples of content that may be covered under this competency.

Infer the climatic zone in which a given area is located based on temperature and precipitation data.

Analyze factors that affect the climate in a given region (e.g., insolation, wind patterns, topography).

Analyze the relationship between the climate of a region and its weather.

Competency 0018

Understand the impact of human activities and natural processes on the atmosphere, theories about the long-range effects of human activities on global climate, and methods of controlling and minimizing these effects.

The following topics are examples of content that may be covered under this competency.

Identify common air pollutants and their sources, and demonstrate an understanding of the effects of air pollutants and atmospheric chemical reactions involving these pollutants.

Demonstrate an understanding of factors that affect local air pollutant concentrations (e.g., population density).

Analyze the theory of global warming due to increased levels of atmospheric carbon dioxide from the burning of fossil fuels.

SUBAREA IV—GEOLOGICAL SYSTEMS

Competency 0019

Understand geochemical systems, the processes of mineral and rock formation, the characteristics of different types of minerals and rocks, and the methods used to identify and classify them.

The following topics are examples of content that may be covered under this competency.

Demonstrate the ability to utilize a classification scheme (e.g., based on physical properties, crystal form, chemical composition) to identify common rock-forming minerals.

Analyze the processes by which different kinds of rocks are formed.

Classify a given rock as sedimentary, igneous, or metamorphic.

Competency 0020

Understand the structure of the earth, the constructional forces that have shaped its surface, theories and evidence of crustal movements, and the effects of crustal movements on landscape.

The following topics are examples of content that may be covered under this competency.

Demonstrate an understanding of the use of seismic waves to infer the earth's internal structure.

Apply the theory of dynamic equilibrium (e.g., isostasy) to explain landscape development.

Analyze evidence for seafloor spreading and plate tectonics.

Apply the theory of plate tectonics to explain landscape development and geologic phenomena (e.g., volcanism, earthquakes) and to predict future movements of landmasses.

Competency 0021

Understand erosional-depositional processes that change the earth's surface (e.g., weathering, erosion) and the relationship between these processes and landscape development.

The following topics are examples of content that may be covered under this competency.

Demonstrate an understanding of the processes of mechanical, chemical, and biological weathering and factors that affect the rate at which rocks weather and soils are produced.

Demonstrate an understanding of the processes of erosion by various agents (e.g., wind, water, glaciers) and factors that affect erosion rates and patterns.

Demonstrate an understanding of the processes by which given landscape features are formed.

Competency 0022

Understand characteristics of the major geologic time divisions and theories and supporting evidence regarding the earth's geologic history.

The following topics are examples of content that may be covered under this competency.

Compare and contrast the conditions and characteristic fossils of the various geologic periods.

Apply the laws and principles of geology (e.g., law of original horizontality, law of superposition) to interpret diagrams of rock strata.

Demonstrate an understanding of the principles, applications, and limits of radioactive dating.

Use paleontological information to infer the geologic history of a given area.

SUBAREA V—WATER SYSTEMS

Competency 0023

Understand the processes by which water moves through the hydrologic system, and use this knowledge to analyze local water budgets.

The following topics are examples of content that may be covered under this competency.

Analyze the components of the hydrologic system (e.g., evaporation, transpiration, infiltration).

Evaluate the effects of various factors (e.g., vegetation, gradient, rock strata) on components of a local water budget.

Analyze the energy transformations that occur as water moves through the hydrologic system.

Analyze the role of the hydrologic system in shaping the earth's surface.

Competency 0024

Understand the processes by which water moves on and beneath the earth's surface.

The following topics are examples of content that may be covered under this competency.

Analyze the factors affecting the flow of water in river systems (e.g., flow velocity, sediment load, cross-sectional stream shape).

Analyze factors affecting the movement of ground water (e.g., aquifers, gradient).

Analyze a cross-sectional diagram of a water table and surrounding rock strata to predict the movement of ground water and the behavior of wells.

Analyze the interrelationship between ground water and surface water.

Competency 0025

Understand the oceanic system; the structure, composition, and properties of the earth's oceans; and the causes and properties of currents and waves.

The following topics are examples of content that may be covered under this competency.

Analyze the composition of seawater (e.g., elements, dissolved gases).

Analyze the relationship between the physical properties of ocean water (e.g., temperature, pressure, density, light) and depth.

Analyze forces affecting surface circulation in the open ocean.

Analyze the effect of waves and tides on coastline formation.

Practice Selected-Response Questions

Competency 0003

Understand the process of scientific inquiry and the role of observation and experimentation in explaining natural phenomena.

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1. A seismologist is planning an investigation into earthquake behavior in a particular region. The seismologist applies the theory of plate tectonics and formulates a hypothesis for regional earthquake behavior that is consistent with that theory. The seismologist can be confident about using the theory of plate tectonics as the foundation for this investigation because the theory:

   A. has been proven as fact.

   B. is supported by a great deal of empirical evidence.

   C. needs no further revision.

   D. supports the desired conclusions.

Correct Response: B. The theory of plate tectonics provides a unifying framework that helps explain diverse geologic phenomena. This theory—that large plates of the lithosphere move slowly around on the earth's surface—was developed as a result of evidence gathered through careful scientific observation and measurement of phenomena such as magnetic patterns on the ocean floor, locations of earthquakes and volcanoes, and the structure and shape of the continents. As new data are gathered, certain elements of the theory may be refined, but the idea that geologic phenomena can be explained in terms of moving plates is fundamental to the study of modern geology.

Competency 0005

Understand types and uses of natural resources, the effects of human activities on the environment, and the need for stewardship to preserve the environmental integrity of the earth's ecosystems.

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2. A town has detected nitrates in its water supply, which is drawn from a reservoir and from a number of wells that tap a small aquifer. The nitrates have been traced to wells in one area. Which of the following is the most likely source of the contamination?

   A. leakage from underground gasoline storage tanks

   B. ash and particulates from upwind industrial stacks

   C. leachate from naturally occurring minerals

   D. runoff from farms and feedlots

Correct Response: D. Nitrates are nitrogen-containing compounds, which are significant components of manufactured fertilizers and animal wastes. These fertilizers and wastes can enter the surface water that runs off of fields where crops are grown and locations where animals are kept in large concentrations. Some of this surface water, along with the nitrogenous compounds dissolved in it, can percolate through the ground, thus introducing nitrates into the water source that supplies the wells.

Competency 0008

Understand the structure, composition, and features of the earth, moon, and sun and the role of technology and exploration in obtaining knowledge about the earth, moon, and sun system.

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3. At a location in Utah, core samples have been taken of sedimentary rocks that formed in a tidal area nearly one billion years ago. These rocks have bands that scientists believe were formed by tides. The bands indicate that at the time the sediments were laid down, the lunar month was shorter than it is now. They also suggest that the length of a day was about 21 hours. Which of the following conclusions are supported by these observations?

   I. The moon was once closer to the earth than it is now.

   II. The earth once tilted less on its axis than it does now.

   III. The orbit of the moon was once more elliptical than it is now.

   IV. The earth once rotated faster on its axis than it does now.

   A. I and II only

   B. I and IV only

   C. II and III only

   D. III and IV only

Correct Response: B. Since the duration of the lunar month is determined by the duration of the moon's revolution around the earth, a shorter lunar month would be possible if the moon were closer to the earth, since in this case the moon's path around the earth would be shorter. Likewise, since day length is determined by the length of time it takes the earth to make one rotation on its axis, a shorter day would be possible if the earth turned on its axis more quickly.

Competency 0011

Understand stars, their motions and life cycles, and the methods and technology used to study them.

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4. An astronomer observes that the light coming from a distant star is shifted toward the red end of the visible spectrum. The best interpretation of this information is that the:

   A. star is increasing in diameter.

   B. temperature of the star is increasing.

   C. distance between the star and the earth is increasing.

   D. star is outside our galaxy.

Correct Response: C. A shift toward the red end of the spectrum in the light coming from the star indicates that the wavelengths are becoming longer. This observation can best be explained by the Doppler effect, which describes changes in wavelength due to the relative motion of a light source and observer. In this instance, relative motion of the star away from the earth causes the wavelengths to elongate and shift toward the red end of the color spectrum.

Competency 0012

Understand evidence regarding the size, structure, scale, and motions of the universe, the Milky Way galaxy, and the solar system.

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5. Some scientists believe that the solar system was formed from condensation of a rotating disk of gas and dust debris produced by a supernova explosion. Which of the following hypothetical discoveries would be the strongest evidence *against* this theory?

   A. A tenth planet is found that orbits the sun in a direction opposite to that of the other planets.

   B. The asteroids in the asteroid belt are found to be remnants of an ancient planet.

   C. Studies indicate that the solar system is more than twice as old as previously thought.

   D. A moon of Jupiter is found to be a captured asteroid.

Correct Response: A. The central idea of the "big bang" theory is that all the planets in the solar system formed from a rotating disk of gas and debris and that this is the reason that all the known planets orbit in the same direction. A planet orbiting in the opposite direction would contradict this theory, so if a planet that orbits in the opposite direction were to be discovered, the validity of the theory would be called into question.

Competency 0014

Understand the properties of water, conditions in the atmosphere that favor phase changes, and the energy relationships among phase changes, cloud formation, and precipitation.

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6. A cumulus cloud begins to form in a warm air mass that is ascending rapidly through a slightly cooler air mass. Which of the following is the most likely cause of the condensation in the warm air mass?

   A. a decrease in temperature caused by a decrease in atmospheric pressure

   B. a decrease in temperature caused by heat exchange between the two air masses

   C. an increase in relative humidity caused by an increase in water content

   D. an increase in relative humidity caused by an increase in the dew point

Correct Response: A. Air pressure decreases with increasing altitude, so an air mass that is ascending will be subject to lower pressure and will expand. The result of the expansion of the air mass is that the air molecules move farther apart, collide less often, and subsequently produce less heat. This leads to a decrease in the temperature of the air mass. This process is called adiabatic cooling. As the rising air mass cools, the water vapor contained in it begins to condense and form clouds because colder air can hold less water vapor than warm air.

Competency 0015

Understand characteristics of broad-scale weather systems and local weather, the relationship between them, and the methods and instruments used to collect and display weather data.

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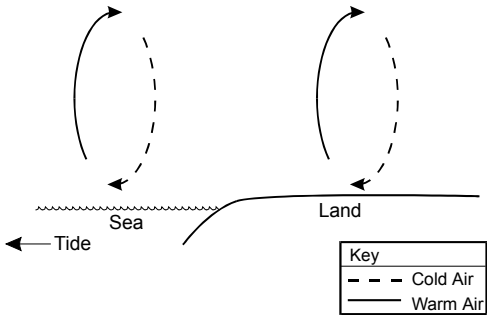
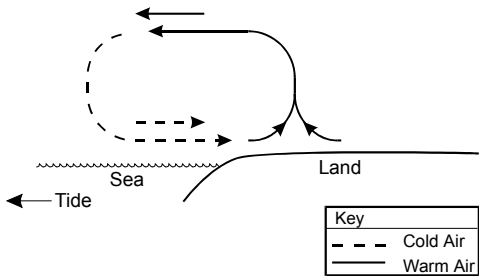
7. Which of the following most accurately represents the air circulation patterns likely to develop on a hot summer afternoon in a coastal area?

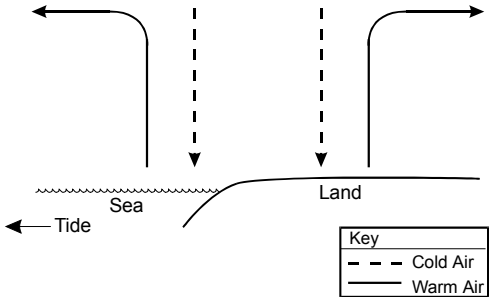
A.



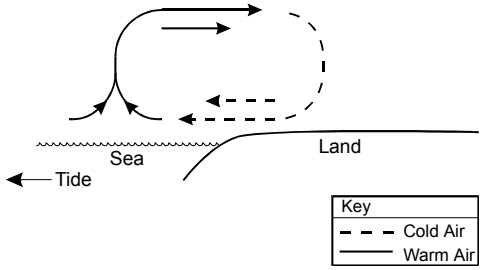
B.



C.



D.



Correct Response: B. On hot summer afternoons in coastal areas, the land heats more quickly than the nearby water. The warm ground also heats the air above it, which creates a thermal low over the land. The air over the water remains cooler, creating a thermal high. This pressure gradient causes the denser, cooler air over the water to move inland along the surface, resulting in a sea breeze. The less dense warm air over the land rises and moves out over the water, where it cools and sinks back to the surface.

Competency 0019

Understand geochemical systems, the processes of mineral and rock formation, the characteristics of different types of minerals and rocks, and the methods used to identify and classify them.

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8. A geologist observes that although the same minerals are present along the two-mile length of an escarpment, the size of the mineral crystals increases from west to east along the escarpment. Which of the following would best explain this observation?

   A. The escarpment is metamorphic. The greatest heat and pressure occurred at the western end.

   B. The escarpment is sedimentary. The eastern end is older than the western end.

   C. The escarpment is igneous. The western end cooled more quickly than the eastern end.

   D. The escarpment is metamorphic at the western end and igneous at the eastern end.

Correct Response: C. The crystal size in igneous rocks is influenced by the rate at which the molten rock cooled. When magma cools slowly, ions can migrate more readily, resulting in the formation of large crystals. By contrast, when cooling occurs rapidly, ion movement is inhibited, resulting in smaller crystals.

Competency 0022

Understand characteristics of the major geologic time divisions and theories and supporting evidence regarding the earth's geologic history.

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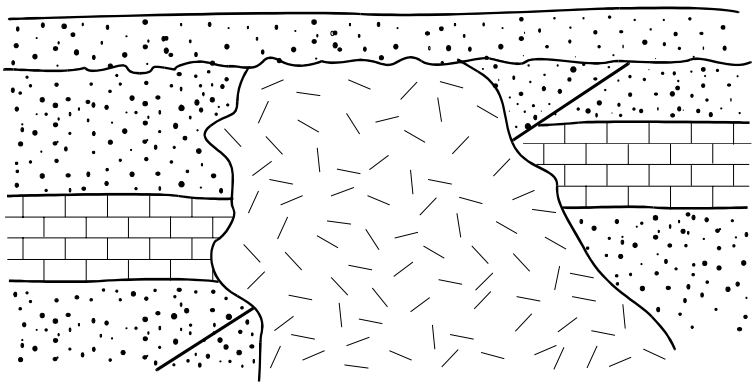
9. **Use the diagram below to answer the question that follows.**



Based on the cross-sectional diagram above, which of the following was the likely sequence of geologic events?

A. sedimentation → intrusion → erosion → faulting → sedimentation

B. sedimentation → faulting → intrusion → erosion → sedimentation

C. sedimentation → folding → faulting → erosion → sedimentation

D. sedimentation → erosion → sedimentation → erosion → faulting

Correct Response: B. The formation of the lower three sedimentary layers preceded their displacement by the fault. The igneous intrusion occurred after the faulting, as is evident by the fact that it cuts across the fault. The flattened top of the intrusion suggests that it was exposed on what was once the surface and underwent erosion. Finally, another sedimentary layer was deposited over the entire area.

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10. A confined aquifer supplies a large number of gushing artesian wells in a small town. As the town grows and new wells are drilled, many of the wells begin to flow more slowly or stop flowing altogether. Which of the following is the most likely explanation?

    A. The limited supply of water originally contained in the aquifer has been depleted.

    B. Over time, the aquifer has gradually changed its position relative to the town.

    C. Over time, the aquifer's underground pressure was increased by the town's wells.

    D. The town's water use has grown to exceed the aquifer's recharge rate.

Correct Response: D. Both the capacity and the recharge rate of an aquifer are finite. In the situation described, the number of wells in the town was originally small enough that the rate at which water was withdrawn from the aquifer did not exceed its recharge rate. As the number of wells increased, however, the rate of withdrawal from the wells exceeded the recharge rate, thus reducing the hydrostatic pressure in the aquifer and reducing the flow to the wells.

11. **Use the information below to complete the exercise that follows.**

A researcher has been hired by a paper company to collect water samples from three locations along a river that flows by the company's production facility. Several industrial contaminants have been reported at hazardous concentrations in an outflow pipe that directs the facility's wastewater into a culvert that drains into the river. The samples collected from the river will be tested for the same contaminants. The researcher's proposed investigative procedures are described below.

1. Prepare for sampling of contaminated surface water by cleaning glass jars with soap and water.

2. Identify three locations for sampling of river water that are all downstream of the paper company facility.

3. Wade into the water at each location with a large bucket and carefully collect enough water with the bucket to fill one 500 mL sample jar, making sure not to spill the potentially contaminated water on skin or clothing.

4. Repeat the procedure at the two other downstream locations.

5. Bring the samples to the lab and label them according to which location they came from and the tests that will be conducted.

6. For each test to be conducted, fill a jar with tap water as a blank for verifying testing accuracy.

7. Until all testing is completed, store all samples in a locked closet.

8. Perform necessary tests for various contaminants first on the sample and then on the blank.

9. Report results to the company.

Using your knowledge of the principles and appropriate procedures for scientific investigations (e.g., data analysis, experimental design, sampling, dependent and independent variables), prepare a response in which you:

- identify two weaknesses in the way the scientific investigation will be carried out and explain why, from a scientific perspective, they are weaknesses;

- describe two modifications that should be made to the investigative procedures that would address these weaknesses and explain how these changes would enhance the scientific validity of the investigation; and

- discuss two reasons why research on this topic could be important or useful to society.

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FOR YOUR REFERENCE ONLY—*The constructed-response item is written to assess understanding in Subarea I, Foundations of Scientific Inquiry, which consists of the competencies listed below.*

Understand the relationships and common themes that connect mathematics, science, and technology.

Understand the historical and contemporary contexts of the earth/space sciences and their application to everyday life.

Understand the process of scientific inquiry and the role of observation and experimentation in explaining natural phenomena.

Understand the processes of gathering, organizing, reporting, and interpreting scientific data; and apply this understanding in the context of earth/space science investigations.

Understand types and uses of natural resources, the effects of human activities on the environment, and the need for stewardship to preserve the environmental integrity of the earth's ecosystems.

Understand how to create, use, and interpret physical and mathematical models (e.g., maps, charts, graphs, diagrams) commonly used in earth/space science.

Understand equipment and materials used in earth/space science investigations, and apply procedures for their proper and safe use.

A Very Good Response to the Practice Constructed-Response Assignment

After reviewing the procedures used by the researcher in collecting and testing samples of water contaminated with hazardous chemicals, I found the proposed procedures were flawed throughout. Safety, accuracy, and accountability are of paramount importance when dealing with suspected or known hazardous materials in the environment. Since cases of industrial contamination involve serious legal issues, the lack of accuracy and accountability becomes a legal matter that may involve federal and state environmental agencies, public health officials, and the courts. Aside from the risk to public health from inaccuracies in the assessment of the contamination problem, an important safety issue is the lack of protective clothing worn by the person collecting the samples. Minimally, gloves, boots, and safety glasses would be worn and, depending on the identity and concentration of the hazardous substances, a protective jumpsuit might be used.

The whole endeavor would be compromised if precautions are not taken to collect, label, store, and test the samples using strict laboratory protocols. From the start, the design of the collection and testing procedure is flawed. Collection jars are not sterilized, data on samples is not recorded properly, and collection locations are not justified or recorded accurately.

Initially, background research should be conducted to determine the most appropriate locations for sample collection and on the behavior of the particular contaminants as they enter the riverine environment. No samples are taken from a location upstream of the suspected discharge point, an essential step to verify the background quality of the river water and to identify any other possible sources of contaminant discharge. Specific locations of sample collection should be recorded and justified in terms of the concerns raised about the particular contaminants involved. Contamination that may be from nonpoint source locations should be researched and taken into account as well (e.g., agricultural and urban runoff, storm drains, residential pesticide use).

It is appropriate to collect a separate sample for each test. Samples should be collected directly from the outflow pipe leaving the industrial facility to verify the kinds of contaminants leaving the facility and their concentration as a reference to compare with upstream and downstream readings. The precise location (i.e., the latitude and longitude, the depth of collection within the stream, distance from shoreline) and character of the stream bed and banks should be recorded. Weather conditions should also be recorded. Care should be taken not to disturb the stream bed as some contaminants (e.g., heavy metals) may be concentrated in the sediments.

(continued)

A Very Good Response to the Practice Constructed-Response Assignment *(continued)*

These observations and recordings should be recorded in a field notebook that may be considered a legal document. Two samples for each test should be collected just in case something happens to a sample. Samples should be labeled at the time they are collected to minimize the possibility of a mix-up. Each sample should be labeled with the time, date, location, collector's name, and the contaminant to be tested for. Any field analysis that is possible should be conducted at the time of collection. This might include recording the temperature, pH, and conductivity of the water. To ensure accuracy of the results it is also important that all samples be stored at a constant cool temperature not accessible to nonprofessionals and are processed in a timely manner by a state-certified laboratory.

Testing blanks should be filled with distilled water, not tap water, and their identity should not be known to the person conducting the testing. Ultimately, to ensure the accuracy of the whole process, a state-certified lab that is independent of the company should be used so the results will be reliable and unbiased should the matter end up in court. The final report summarizing the data collected, background research, investigative protocol, and any associated maps, field notes, and photographs should be completed and delivered to the client and the relevant state agencies.

The reasons I feel this research is important to society are that as a society we must protect our freshwater resources and protect the health of the public, while also planning strategies for identifying and cleaning up contaminants in the environment. Achieving a greater understanding of how contaminants move through the environment is also an important part of the ongoing identification and cleanup of waste sites, hazardous spills, and the unregulated discharge of pollutants.

CONSTRUCTED-RESPONSE ASSIGNMENT SCORING

All responses to OSAT constructed-response assignments (written and oral) are scored using scoring scales that describe varying levels of performance. These scales were approved by committees of Oklahoma educators who reviewed both the performance characteristics and the scoring scales.

Each response is scored by multiple scorers according to standardized procedures during scoring sessions held immediately after each administration of the CEOE. Scorers with relevant professional backgrounds are oriented to these procedures before the scoring session and are carefully monitored during the scoring sessions.

A constructed-response assignment response is designated unscorable if it is blank, not on the assigned topic, illegible or unintelligible, not in the appropriate language, or of insufficient length to score. If you do not provide a scorable response for each constructed-response assignment on your test, you cannot pass the test regardless of your scores on the other section(s) of the test.

Sample Performance Characteristics for Constructed-Response Assignments

PURPOSE	The extent to which the response achieves the purpose of the assignment
SUBJECT MATTER KNOWLEDGE	Accuracy and appropriateness in the application of subject matter knowledge
SUPPORT	Quality and relevance of supporting details
RATIONALE	Soundness of argument and degree of understanding of the subject matter

Sample Scoring Scale for Constructed-Response Assignments

SCORE POINT	SCORE POINT DESCRIPTION
4	**The "4" response reflects a thorough knowledge and understanding of the subject matter.** • The purpose of the assignment is fully achieved. • There is a substantial, accurate, and appropriate application of subject matter knowledge. • The supporting evidence is sound; there are high-quality, relevant examples. • The response reflects an ably reasoned, comprehensive understanding of the topic.
3	**The "3" response reflects a general knowledge and understanding of the subject matter.** • The purpose of the assignment is largely achieved. • There is a generally accurate and appropriate application of subject matter knowledge. • The supporting evidence generally supports the discussion; there are some relevant examples. • The response reflects a general understanding of the topic.
2	**The "2" response reflects a partial knowledge and understanding of the subject matter.** • The purpose of the assignment is partially achieved. • There is a limited, possibly inaccurate or inappropriate application of subject matter knowledge. • The supporting evidence is limited; there are few relevant examples. • The response reflects a limited, poorly reasoned understanding of the topic.
1	**The "1" response reflects little or no knowledge and understanding of the subject matter.** • The purpose of the assignment is not achieved. • There is little or no appropriate or accurate application of subject matter knowledge. • The supporting evidence, if present, is weak; there are few or no relevant examples. • The response reflects little or no reasoning about or understanding of the topic.
U	**The response is unscorable because it is illegible, not written to the assigned topic, written in a language other than English, or of insufficient length to score.**
B	**There is no response to the assignment.**

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